The Refraction and Dispersion of Argon, and Redeterminations of the Dispersion of Helium, Neon, Krypton, and Xenon.

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So far as we are aware only four determinations of the refractivity of argon have been published. These are as follows:—

Observer.	Wave-length.	$(\mu-1)\,10^7$.	Remarks.
Rayleigh*	White	2808	Assuming the value 2922 for air ($\lambda = 5894$).
Ramsay and Travers†	,,	2828	
Burton‡	6563	2829	The results for these and four other lines are expressed by $\mu-1 = 0{\cdot}0002792 + \frac{1{\cdot}6\times10^{-14}}{\lambda^2}$.
	5896	2837	
Ahrberg§	6439	2796	
	5790–70	2803	
	5461	2816	
	4359	2851	

* 'Roy. Soc. Proc.,' vol. 59, p. 203.

† 'Roy. Soc. Proc.,' vol. 64, p. 190, and vol. 67, p. 331.

‡ 'Roy. Soc. Proc.,' A, vol. 80, p. 390.

§ Ahrberg, 'Inaug. Diss. Halle,' 1909.

The first two determinations only deal with the refraction of white light, while the value of Ahrberg's results is limited by the fact that he was only able to count 12 bands in the red and 50 bands at the other points selected; so that his whole dispersion effect must have been about one band in the violet, a number which is insufficient to ensure great accuracy. Another determination may not, therefore, be considered superfluous.

The specimen of argon used by us was kindly lent by Sir William Ramsay, by whom it was purified. The spectrum showed a trace of hydrogen, but none of other gases. The mean of seven experiments gave a refractive index of 1·00028230 for the wave-length 5461. These determinations varied between 1·00028258 and 1·00028183. The dispersion was measured for the seven wave-lengths 6438·5 (Cd), 5790·5 (Hg), 5769·5 (Hg), 5460·7 (Hg), 5209·1 (Ag), 5085·8 (Cd), 4799·9 (Cd).

The first two columns of the following table show the results. The refractivity is here doubled in order to facilitate comparison with the diatomic gases:—

Table I.—Dispersion of Argon.

$\lambda \times 10^8$.	Observed $(\mu-1)\,10^8$.	Calculated.	Difference.
6438·5	56173	56174	+1
5790·5	56346	56346	0
5769·5	56345	56353	+8
5460·7	**56460**	56459	−1
5209·1	56559	56560	+1
5085·8	56612	56615	+3
4799·9	56764	56760	−4

For the reasons given in a previous paper* the dispersion formula $\mu-1 = C/(n_0^2-n^2)$ was adopted; and the values of the constants were calculated, by the method of least squares, from all the determinations except that for λ 5769·5, which was evidently affected by error (a cause for which could be assigned). The value of C was found to be $9{\cdot}43264 \times 10^{27}$ and of n_0^2 to be $17008{\cdot}9 \times 10^{27}$. The numbers calculated from this formula are given in Column 3 and the differences between the calculated and observed results are shown in Column 4. It will be seen that the *relative* refractivities for different wave-lengths can generally be trusted to one or two points in the fifth significant figure. In these experiments the number of bands read (λ 5461) varied between 300 and 400, and the discrepancy between observation and experiment corresponds to an error of less than one-fiftieth of an interference band, a degree of accuracy greater than there was reason to expect.

Our values of the constants compare as follows with the results of Burton and Ahrberg when their figures are expressed in the formula used by us:—

Observer.	$C \times 10^{-27}$.	$n_0^2 \times 10^{-27}$.
Burton	9·124	16335
Ahrberg............................	7·437	13516
C. and M. Cuthbertson	9·43264	17008·9

Although we had recently published determinations of the refractive indices of the other inert gases, we were tempted by the improvement† in the source of light and in the disposition of our apparatus to repeat observations on them in order to bring them all up to the same level of accuracy.

Table II shows the experimental results (doubled as in the case of argon).

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* 'Roy. Soc. Proc.,' vol. 83, p. 152.

† We used Dr. T. M. Lowry's arc with poles of cadmium and silver alloy. By substituting for one electrode an alloy of silver and lithium, kindly made for us by Messrs. Johnson and Matthey (about 98 per cent. Ag, 2 per cent. Li), we were able to use the lithium line λ 6707·85 in the later experiments.

The figures given in the columns "calculated" were derived from the constants of the equation

$$\mu - 1 = \mathrm{C}/(n_0^2 - n^2)$$

shown in Table III, which were calculated from the observations by the method of least squares. It will be found that the discrepancies between the observed and calculated results are of the same order as in the case of argon. The maximum number of bands read in the case of each element is given in the same table. The figures given in large type are the absolute values of the refractivities for λ 5461 which were assumed for the calculation of the dispersion. They were not redetermined, but taken from our previous measurements.

Table II.—Redeterminations of the Dispersion of Helium, Neon, Krypton, and Xenon. $(\mu - 1) \times 10^8$.

$\lambda \times 10^8$.	Helium.		Neon.		Krypton.		Xenon.	
	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.
6707·85	—	—	—	—	85066	85055	13946	13946
6438·5	6972·6	6972·8	13403	13402	85160	85168	13974	13973
5790·5	6983·4	6983·1	13421	13420	85522	85518	14055	14056
5769·5	6963·8	6983·5	13421	13421	85529	85531	14058	14059
5460·7	**6990·0**	6989·8	**13432**	13431	**85748**	85747	**14109·8**	14110
5209·1	6996·2	6995·9	13442	13442	85955	85953	14158	14159
5085·8	6998·4	6999·1	13446	13448	86068	86066	14185	14185
4799·9	7008·0	7007·8	13462	13462	86361	86363	14257	14256

Table III.—Refractivities of the Inert Gases.

Values of Constants in the Equation $\mu - 1 = \mathrm{C}/(n_0^2 - n^2)$.

Element.	$\mathrm{C} \times 10^{-27}$.	$n_0^2 \times 10^{-27}$.	Maximum number of bands read.
Helium	2·42476	34991·7	349
Neon	5·18652	38916·2	440
Argon	9·43264	17008·9	400
Krypton	10·6893	12767·9	430
Xenon	12·2418	8977·87	550

It is satisfactory to find that the values of n_0^2 now obtained by these more accurate measurements do not differ in any case by more than 2 per cent. from the values published by us in September last.*

For the loan of all these gases we have to thank Sir William Ramsay, and we have also pleasure in recording our obligations to Prof. Trouton, and to the Royal Society for a grant.

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* 'Roy. Soc. Proc.,' A, vol. 83, p. 149, 1909.